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THE SPECIES COMPLEX IN BIOLOGY AND EDUCATION[1]

By Dr. ALBERT DAVIS MEAD

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THIS afternoon I propose to discuss a certain mental trait which looms conspicuously in the background whenever I reflect upon the history of biology or upon academic procedures as I have observed them these many years. It is the innate propensity of active minds to form species, *i.e.*, successively to make distinctions, to point out similarities and then to assemble the things that are alike into their kinds. It applies to everything from chemical elements to college fraternities. Since the Latin word "species" is synonymous with the English word "kind" even to the point of being adequately indefinite I shall employ it in a wide and general sense which, indeed, accords with its earlier usage.

This mental trait is not a simple one. It is made up of a strong emotional factor, an inborn urge to put things in order and, alas, keep them there; of the intellectual faculty of discernment and discrimination which perceives distinctions and similarities; and of the constructive imagination which makes it possible to assemble in the mind things that are widely separated in space and time. For convenience I presume to call this trait the species-forming complex or, for short, the "species complex."

I shall first point to a few characteristic effects, good and bad, of the operation of the species complex in general; then to some of its accomplishments in the field of biology; and finally, shall venture to suggest that the recognition of the characteristics of this trait in human beings is desirable as we face the problems of the day inside and outside of the university.

The species complex often manifests itself in the

[1] Address at the Graduate Convocation of Brown University, June 17, 1939.

degree of importance assigned to nice distinctions and to exact definitions. It is, of course, to its credit that it does seek to make fine and clear-cut distinctions; but so highly is this function esteemed in academic circles that extraordinary powers of fine discrimination are sometimes mistaken, by the unwary, for scholarship itself. Again, instinctively we admire that which is definite, unequivocal and normal and we tend to ignore that which is vacillating, confused or abnormal, *i.e.*, mugwump, the mule and the freak. Is there not, however, a salutary moral to be found in the reflection that not long ago the political mugwump turned the tide of a major election in all but the two American states; that the hybrid established the science of genetics; and that the freak, under the polite name of mutation, largely restored the waning prestige of natural selection as a major factor in the modus operandi of evolution? Clear, sharp incisive definitions are admirable, but only when they do not throw out of proper consideration items which may be potentially important.

The most commonly recognized manifestation of the species complex is the blind adherence, or better the emotional adherence, to some particular definition of a species once it has been established, especially when the species in question is a doctrine of politics, economics, social organization, government or religion. Perhaps no other manifestation has greater possibilities for usefulness, and also for mischief. It engenders loyalty, it promotes solidarity, and it tends to satisfy the intuitive desire for a solid base or anchorage that is once and for all secure, immovable and permanent. But it tends also to favor dogmatism and to prevent or retard the candid, unprejudiced, fruitful study of relationships. It encourages debate and even war, and discourages deliberation as a method of deciding issues. This insistence upon permanence of species may sometimes have its explanation in proprietary interests or pride as the founder or beneficiary of the particular system, or in a long-time commitment to it as sponsor or adherent. But whatever the reason, and despite the useful service which it may perform in preserving the existing order, the sinister effects of this insistence are, as we all know, often very far-reaching. By way of contrast one of the significant contributions of science to humanity has been its attitude toward the permanence of its own hypotheses. For example, since many of us were studying science in college such fundamental tenets of classical physics as the indestructibility of matter, the conservation of energy and the integrity of the atom have been relinquished and superseded without serious emotional disturbance. We look forward toward the millennium when this attitude shall generally prevail, when deliberation shall everywhere be exalted above debate and missions shall give way to parliaments.

The greatest of all adventures in the study of species has been in biology; naturally so because of the characteristics of living material—the incomparable diversity of its forms and the paradox of their being at the same time persistent and changeable. Conversely, the greatest episode in biology has been the study of species plus the interpretation of its results. I refer to the stupendous enterprise which, in the eighteenth century, was inspired and for many years largely conducted by that extraordinary genius, the "immortal Swede," Linnaeus, and which was interpreted later in the Darwinian presentation of the hypothesis of evolution. This enterprise was a well-organized world-wide drive of which the objective was nothing less than to discover, describe, name and classify every living thing—as the housekeeper in Maine would say, to "neaten up" the living world and put it in "apple pie order." Literally the whole world was combed for new species by the agents and correspondents of the great impresario; and it should be remembered that the world was then a score of times larger than it is to-day.

As the work progressed it gained momentum, and in fact it has never ceased. At the present time the number of existing species of plants and animals recorded, described and named in accordance with the Linnaean system is considerably over a million, and new ones are being added continually. (Several have been announced this week.) It is evident, moreover, that the number of species existing to-day is only a fragment of the total number that have inhabited the earth.

Since this was by far the greatest, most systematic and most mature species study ever undertaken it should be profitable to review its consequences, immediate and latent. Directly from it two major generalizations were derived, both of them highly significant, and both utterly contrary to expectation and to immemorial tradition; first, that the number of species of plants and animals is of an entirely different order of magnitude than had ever before been imagined; second, that a specificity itself is an attribute equally of all living things, which means that every individual organism living or dead, animal or plant, the eagle or the earthworm, the rose or the mildew on its leaves, has an equally valid passport certifying its good standing as a regular member of some species; and that any individual amoeba, shellfish or insect, with respect to lineage and pedigree, stands, in the eye of nature, on equal footing with a Pharaoh.

So much for the direct consequences. The greater significance of this monumental labor was latent and potential. It became manifest and effective, not by the distinguishing of more species (although this work continued), but, on the contrary, by a half century of vigorous research into the relations between the very species that had been distinguished. Herein precisely

one of the practical lessons which this long and nature experience in biological species-study holds for the workers in other domains.

Several ingenious ways of getting at these relations were found out by the generations following Linnaeus. Let me recall very briefly three of them. First, the comparing of the whole internal and external structure of representatives of similar species established a new biological discipline, the science of morphology. With this work the name of Cuvier must always be associated, but it also held the distinguished attention of the poet Goethe and of a long list of savants of the early nineteenth century.

Another means of access to the relationships of species was paleontology, with which also the name of Cuvier must be associated. We commonly think of paleontology as relating to extinct species but, for purposes of this discussion, that which it reveals about living species is even more important. Through the study of fossils it became evident, not only that the kangaroo once lived a wild life in Paris, the mastodon (if not the elephant) was at home in Albany, the sabre-toothed tiger wrought havoc in Hollywood, and the superannuated giant-sloth retired to Pasadena, but also that man himself, and nearly all the kinds of animals and plants that are now living, have existed upon the earth only a few minutes of the geological day. Among all the creatures that have dwelt upon the earth since the beginning, they are comparatively recent arrivals.

A third means of access, geographic distribution, revealed a most significant relation among sciences; a relation which obtains also in human cultures and therefore directly concerns one of the paramount problems of our day and generation. The biologists have a name for it, but in plain English it is this: Species naturally occupy definite areas limited by barriers, geographic or physiologic, which, unaided, they can not cross but, once assisted across the barriers, they not only may continue to exist but may enjoy "the more abundant life," like rabbits in Australia and Buddhism in China and Japan. To this phenomenon in relation to human cultures, I shall revert later.

Now geographic distribution is not a subject to arouse the enthusiasm of the man on the street, yet it was the prolonged reflection upon this phenomenon, as he had observed it in the Galapagos Islands, that greatly stirred the imagination of the reputedly unemotional Darwin and first turned him toward the evolutionary interpretation of the nature of species. In 1844, seven years after returning from the voyage of the *Beagle,* he wrote to Hooker, the English botanist:

> . . . I have now been, ever since my return, engaged, in a very presumptuous work, and I know no one individual who would not say a very foolish one. I was so struck with the distribution of the Galapagos organisms, etc., and with the character of the American fossil mammifers, etc., that I determined to collect, blindly, every sort of fact, which could bear in any way on what are species. . . . At last, gleams of light have come, and I am almost convinced (quite contrary to the opinion that I started with) that species are not (it is like confessing a murder) immutable.

That all these general phenomena and others like them probably held the key to some great common mystery did not escape the notice and the comment of the savants of the nineteenth century. Questions about the significance of these constant relations were inevitable and insistent: Why the morphological resemblances? Why the short duration of a species? Why the apparently arbitrary restriction of a species to a single natural habitat?

The hypothesis of organic evolution as presented by Darwin in 1859 was formulated as an answer to these and similar irrepressible questions. A revised hypothesis of special creation as presented by Professor Louis Agassiz, also in 1859, was another and a very different answer.[2]

Great issues were at stake in these strictly alternative answers; nothing less in fact than the question of the place of man in the universe and of the operation of secondary causes in the living world.

The service which this gifted naturalist, Agassiz, performed in clarifying the evolution hypothesis by his adverse criticism, which was continued for fourteen years and up to the time of his death, is not always appreciated. Agassiz did not deny the validity of the relations between species as demonstrated in morphology, paleontology and geographic distribution—he emphasized them; but he gave to all of them severally and collectively an interpretation which showed what extraordinary postulates were required to adapt and adjust the time-honored doctrine of special creation to those newer findings.

In Agassiz's view, the human hand and the bat's wing have an identical plan of structure because the architect who designed both had the same plan in mind. He explained the fact that species live only a short period in geologic time by postulating an indefinite number of successive creative periods. To explain the

[2] Referring to the phenomena of morphology, paleontology and geographic distribution Agassiz wrote in 1863 in "Methods of Study in Natural History," pp. 100–102:

> What, then, does this correspondence teach us? . . . Surely not that the connection between animals is a material one. . . . If, then, this connection is not a material one, what is it?—for that such a connection does exist throughout the Animal Kingdom, as intimate, as continuous, as complex, as any series which the development theorists have ever contended for, is not to be denied. What can it be but an intellectual one? These correspondences are correspondences of thought . . . the same thought that spans the whole succession of geological ages controls the structural relations of all living beings as well as their distribution over the surface of the earth. . . .

enigma of geographic distribution, he postulated the special creation of each species in the region it now occupies.

The difference between the tenets of Darwin and Agassiz hinges on a cardinal difference in the definition of organic species or, as Darwin himself put it, on the question, "What are species?" To Darwin, species were abstract things, the temporary phases or manifestations of a continuous series, having separate entities only as infancy, childhood, youth, manhood and old age would have specific and separate entities if there were no knowledge of the transition from one to the other within a single individual lifetime. In fact, the child of five years has no direct knowledge of this transition, and so to him grandfather has always belonged to the distinct species "old man"; and father and mother too have always been grown-ups. In other words, were all facts known the exact lines separating species would be as elusive as lines separating the several stages of a man's life, and the search for them as futile as grappling for the equator. To Agassiz, on the other hand, a species was a concrete entity, in the sense that it was the sum total of all the individuals descended from an original pair. In summary, it might almost be said that Agassiz and his school sought to discover species; the evolutionists made them.

That, in biology, species turned out to be abstract entities and that species grade one into another does not mean that they have no legitimate status. It is legitimate and useful to distinguish infancy, youth and old age, although we know that somewhere in time one merges into another. For that matter, every biologist realizes that the term "individual," as applied to a particular animal or to a man as a physical organism, is also an abstract and indefinite one. The process of maturation, fertilization and early development of the egg are so perfectly continuous that, even when the whole span from one generation to the next is observed continuously under the microscope in concrete material form, the observer can not point to an exact moment when the egg becomes a new individual. To indicate that moment would be an utterly arbitrary act.

The profound, far-reaching consequences of the wide acceptance of the hypothesis of organic evolution is a matter of history. It directly involved mankind in new material relationships with the other animal species. It brought the living world wholly under the immediate operation of secondary causes, as the astronomical discoveries and interpretations had brought the inanimate world centuries earlier. It established a new kind of biological order. It created a new respect for things that lie in the indefinite zone between adjacent categories. It conduced to the general adoption of the genetic view-point in other domains of thought. Would that Linnaeus could behold how great a matter a little fire kindled!

As I reflect upon the considerable number of discussions which I have listened to or have read in the past four or five decades concerning the aims, purposes, organization, programs and procedures of collegiate education, the impression deepens that there is an increasingly abundant and diversified fauna and flora of educational propositions which would profit by the same kind of analysis and treatment; which invite and challenge the genius of a Linnaeus to distinguish the legitimate species, a Cuvier to compare them and to demonstrate their fundamental relationships, and eventually a Darwin to construct out of these relationships a new rational order and unity in a science of education.

However, this is the comprehensive task which confronts the generations to come. This afternoon I shall refer simply to one unfortunate characteristic of the species complex in the educational field, namely, the unconscious tendency to confuse convenient distinctions with incompatible alternatives—the tendency to set over against each other as more or less antithetical certain factors, in the methods of teaching and learning or in educational purposes, whose relationships to each other are really so very important that they ought not to be thus obscured; but, on the contrary, ought to be regarded as a subject of major concern.

For example: Humanities set over against the sciences as the substance of a liberal education; teaching against research as the function of the faculty and as a criterion of the usefulness of a professor; diversification against specialization as the way to comprehensive understanding; pedagogical training against knowledge of subject-matter as the best preparation for teaching; production of a continuous apostolic succession of "scholars" against the perfusion of the laity with the extract of scholarship, as the function of the university and the criterion in the selection and the training of students; classics against studies of modern thought and affairs as preparation for life; and many others.

The false antithesis between science and the so-called humanities is, perhaps, the most deplorable of all these examples. It is unwarranted and unnecessary, and is disastrous to the great interests of both. Philosophy, literature and art need constantly the substantial contributions of science. Science needs the penetrating criticism of philosophy to preserve its equilibrium and it needs the wings of literature and art to bear its conclusions to their destination.

Unhappily both the intellectual factor of the species complex and the emotional factor contribute to keeping science and the humanities apart. The chief role of science in college, that of aiding the student in building his own Weltanschauung, is not kept sufficiently in evidence. Again science is still defined occasionally as the study of the stage upon which man plays his part;

the humanities as the study of man himself. So to restrict science is, of course, to overlook that most pertinent corollary of organic evolution which admitted man into the association of animal species and conferred upon him all the rights and privileges thereunto appertaining. This made the manifestations of his mental and emotional life amenable to investigation by ordinary scientific methods. The findings of experimental and genetic biology and psychology are then common assets of science and the humanities.

Probably the instinctive or emotional component of the species complex must be held accountable for the notion that the sciences belong on McGuire's side of the railroad track; the nicer humanities on the other side in the older and better residential district. A former colleague at Brown used gleefully to relate the adventure of an ardent devotee of the humanities when on an exploring expedition through a biological laboratory; how her amazed delight over the exquisite beauty of color and texture of a section under a microscope suddenly turned to dismay when she learned that the object of her admiration was the kidney of a rat.

The idea that specialization necessarily conduces to narrowness of vision is a matter on which I speak with feeling and assurance, for I gave four years of merry youth to the intensive and extensive study of the egg of a worm under the impression, which has in no wise diminished through the years, that the polychaetous annelid in the ocean, as truly as "the flower in the crannied wall," is custodian of the eternal mystery. To change the figure abruptly; in delving below the surface in search of the underlying relations of things, one may start his tunnel from one point or from ten points or from fifty points. The number of entrances does not determine the extent of the ramifications.

To ask whether it is the obligation of the college to produce a succession of scholars or to educate the laity is like asking whether it is the business of the germ-plasm to produce more germ-plasm or to produce a corporeal body. It must do both, for if it fails in either the race perishes. In a democracy it is the prospective laity who will perpetually decide whether or not the college shall exist and, if existing, shall be bond or free. It is essential that the layman, even though himself not a scholar, shall have a sympathetic understanding of the content and aims of scholarship, and this is best learned in college. The prospective scholar, that is the academic germ-plasm, must then continue to produce still other scholars but also still other laymen.

Finally, a word concerning a general species problem of the future. If there are responsible institutions in the world, they are the colleges and universities situated in and supported by the democracies. These institutions must play the part of seers and prophets; they must lead and not follow in the thought of the times. Nevertheless, and because this is so, the conditions that obtain in the world in each generation are necessarily reflected in the total educational program of the college.

We have already observed that the biological phenomena attending geographic distribution of plants and animals, especially the effects of isolation, apply also to human cultures. Isolation, by means of more or less effective barriers, has been a primary condition both of the origin and the maintenance of these cultures; but it is abundantly evident that human cultures may thrive in regions other than those in which they originated. At the present time the confining barriers that have hitherto separated human cultures and have tended to maintain them as distinct are being broken down with unprecedented swiftness and unprecedented thoroughness.

The consequent complete, sudden, world-wide commingling of cultural species will be, I venture to say, the central problem of coming generations—even taking precedence over the problem of the vanishing frontiers.

It is true that the interpretation and mixing of cultures has been slowly going on for ages untold; that no human culture nor human race, for that matter, is pure, unmixed and homogeneous; but we have now entered upon a period of cultural diffusion that is something new under the sun. Hitherto cultures have spread from this or that center, sometimes very far indeed, but yet have had their territorial and ethnic limits. To-day they start from many centers at once and the earth is their limit. Hitherto the spread of a culture was determined by some governmental power which had a locus, Thebes, Athens, Rome, Agra, Peking. To-day it is spread by the instrumentality of science, which has no locus either territorial or political.

In the future, unless the existence of the science of physics and the technology of engineering are forgotten by civilized man, the airplane, telephone, radio, phonograph, cinema and their successors will continue to convey goods, persons and cultural ideas to and fro incessantly and almost or quite instantaneously over the whole world in defiance of every geographic and political obstacle. Not America, but the world is becoming the melting pot of cultural ideas.

What is to be the outcome of this, who can tell? It seems inevitable that the present cultural species, including systems of government, economics, ethics, morals, religions and philosophies, can not maintain themselves unmodified in the new conditions, but that from them new species will arise.

The species problem of the future is—how to direct the course of this inevitable cultural evolution so that the new species will include the finest elements that experience can contribute from all quarters of the world.

None should be better qualified to attack the problem than those prospective scholars, and laymen also, whose complex of impelling motives, powers of discernment and discrimination, and constructive imagination it is the privilege of the college and the university to educate.

SCIENTIFIC EVENTS

THE CORNELL ORNITHOLOGICAL EXPEDITION

THE Cornell Ornithological Expedition, under the leadership of Dr. Arthur A. Allen, head of the department of ornithology at the university, returned to Ithaca on September 3 after a four-months journey to the southwest and the west coast.

Color movies and sound records of the Attwater prairie chicken, the rare trumpeter swan and the almost extinct California condor were obtained.

Albert R. Brand, research associate in ornithology at Cornell, a retired stock broker who is an authority on the sound recording of bird-songs, provided funds for the expedition, which left Ithaca on May 2 in a sound truck and traveled over 12,000 miles. The truck was equipped not only for recording the songs and calls of birds and making color-films, but with camping facilities. Assistants to Dr. Allen were David Allen, his thirteen-year-old son and Charles Brand, son of the sponsor of the expedition.

The object of the trip was to secure recordings of the songs and calls of birds new to the Cornell collection; to make color-films of as many birds as possible; to inspect various wildlife refuges and conservation projects of the different states through which the expedition passed and of the Federal Government and to gather as much data as possible relative to the organization and management of these projects for course-work to be conducted at Cornell.

Describing the expedition, Dr. Allen said:

> We proceeded first to Texas and Louisiana, following the southernmost route, through Brownsville, El Paso and Tucson, to Pasadena and Berkeley, where I gave a course in ornithology at the University of California, between June 26 and August 4. On the return we took the northern route, through Oregon, Washington, Montana, North Dakota, Minnesota, Michigan and Ontario.
>
> We visited about two dozen of the state and federal wildlife projects, including seven of the national parks. We recorded the songs or calls of over a hundred kinds of birds not previously recorded; and we secured color-films of about 120 species, taking about 6,500 feet of color-film and 1,200 stills, which will greatly improve our classroom instruction, as well as being used to illustrate public lectures and general articles.

One of the accomplishments of the trip was the discovery of the nest of the coppery-tailed trogon, a tropical species which is found in the mountains of southern Arizona. The ornithologists of Arizona have been hunting for this nest unsuccessfully ever since the bird was first discovered in Arizona, about fifty years ago. The Cornell expedition was fortunate in being able to locate the nest and secure recordings of its voice and color-films of the bird, which has the reputation of being the most beautiful bird in North America. Other interesting or colorful birds recorded and filmed were the roseate spoonbills, on the Texas coast, the purple gallinules of Louisiana, wild turkeys, chachalacas, California, Gambel's and mountain quails, pelicans, vermillion flycatchers, cardinals, western tanagers and blue grosbeaks.

BALLOON FLIGHTS INTO THE STRATOSPHERE

THREE recent flights into the stratosphere over Beltsville, Maryland, by means of groups of rubber sounding balloons reached heights of 14 to 16½ miles above the earth. The balloons, sent up as a joint project by the National Geographic Society and the National Bureau of Standards, carried on each flight with an "observer," an ingenious robot consisting of electric batteries, a tiny motor, photo-electric cells, moving screens and radio tubes.

The object of the flights was to gather additional information about the atmosphere's ozone layer—an important concentration of the gas which screens away from the earth's surface certain rays of sunlight injurious to vegetable and animal life. The metal and glass robot made "readings" of the varying concentrations of ozone at different altitudes and automatically radioed them to a receiving station on the ground. The results are being compared with other observations for a later report by the National Bureau of Standards.

On each of the three flights the lifting power was furnished by six rubber, hydrogen-filled balloons attached in tandem. Four-and-a-half feet in diameter when they were released, these balloons expanded to diameters of 14 feet or more in the rare upper air near the top of the ascents.

The string of balloons continued to rise until one of them burst as a result of expansion. The remaining balloons lowered the observing apparatus slowly to the ground and in every case it was recovered. The flights were made under the supervision of Dr. Lyman J. Briggs, director of the National Bureau of Standards, and Dr. W. W. Coblentz, chief of radiometry at the bureau.

In the hope of reaching greater altitudes for the cooperative study of ozone concentrations, the National

Geographic Society is now having large rubber balloons fabricated. In the meantime improved instruments for detecting ozone and for radioing information back to earth are under construction in the laboratories of the National Bureau of Standards.

COURSES IN MODERN MANUFACTURING AND RESEARCH

NEW YORK UNIVERSITY, the Polytechnic Institute of Brooklyn and the Stevens Institute of Technology, in cooperation with the Westinghouse Electric and Manufacturing Company, have announced a series of post-graduate courses in industry which will enable selected graduate engineers to study modern research and manufacturing methods and earn credit for masters' and doctors' degrees.

These courses are the first to be held in the New York metropolitan area in which an industrial concern has cooperated with a group of educational institutions to provide training for advanced degrees to graduate students. They will be similar to those held with the cooperation of Professor H. E. Dyche, head of the school of electrical engineering at the University of Pittsburgh. As a result of graduate study in these classes in the past twelve years, sixty-six students have been awarded masters' degrees and six students Ph.D. degrees.

Students chosen for enrolment in the New York classes will include graduate engineers now employed by the Westinghouse Company and graduate students in engineering from the three cooperating schools. A joint committee, including Dean Erich Hausmann, of the Polytechnic Institute of Brooklyn; Dr. H. J. Masson, of New York University; Dean F. C. Stockwell, of Stevens Institute of Technology, and J. H. Belknap, manager of technical employment and training for the Westinghouse Company, will examine students and supervise the courses.

Among the first courses authorized will be classes in advanced illumination and in symmetrical components. D. W. Atwater, manager of the commercial engineering department of the Westinghouse Lamp Division and past president of the Illuminating Engineering Society, has been appointed Westinghouse lecturer for the class in advanced illumination. The course, following advanced study procedure in technical schools, will consist of two-hour lectures each on Monday nights, for sixteen weeks at the Westinghouse offices in New York City. The course on symmetrical components, dealing with electrical distribution systems, will be taught by B. V. Hoard, engineer of the Westinghouse Meter Works at Newark, N. J., and S. H. Wright, of the engineering department at Pittsburgh. Instruction will include details of technical procedure in current laboratory research and commercial production. Engineers in the industry will present the latest developments in each field.

MOUSE GENETICS

A CIRCULAR letter signed by L. C. Dunn, W. H. Gates, G. D. Snell and W. L. Russell was recently forwarded to biologists interested in mouse genetics, asking for opinions with regard to the possible establishment of a Committee on Mouse Genetics Nomenclature and of a Mouse Genetics News Service. As a result, at the meeting of the International Congress of Genetics at Edinburgh Professors F. A. E. Crew and L. C. Dunn and Dr. G. D. Snell were appointed a Committee on Mouse Genetics Nomenclature.

A meeting with Dr. A. L. Hagedoorn (Holland) in the chair was called to consider a set of nomenclature rules drawn up by the committee and to discuss details of the News Service. Twenty-five members of the congress were present. The recommendations of the meeting as regards nomenclature were submitted to the committee.

The offer of the director and staff of the Roscoe B. Jackson Memorial Laboratory in Bar Harbor, Maine, for the publication in mimeographed form of the *Mouse Genetics News* was gratefully accepted. It was suggested that a register of stocks and the various Pure Lines should be drawn up in order to end the confusion in the naming of Pure Lines used in various laboratories which has arisen during the last few years. It was recommended that stock lists of all the laboratories concerned should be published from time to time. It was further suggested that notice should be given by a laboratory before any stocks are discontinued; it has happened several times in the past that valuable material has been irretrievably lost, because every laboratory has relied on other places for its maintenance. It is proposed that the News Service should also arrange for exchange of stocks, and it is hoped that its activities may be extended to rabbits and other rodents, and it is suggested that an appeal be made to all laboratories concerned to collaborate wholeheartedly by promptly answering correspondence and sending information.

The meeting discussed the establishment of centers, preferably in the United States for the maintenance and safe keeping of stocks, particularly of genes (pathological and otherwise). It was pointed out that the continuity of genetical work depends on keeping genes alive, as genes which have died out are as irrevocably lost as extinct animal or plant species. It was urged that this matter should receive the immediate consideration of the News Service and that an appeal should be made to the Carnegie and Rockefeller Foundations for financial assistance.

THE AMERICAN ASSOCIATION OF MUSEUMS

THE San Francisco meeting of the American Association of Museums, which met from June 26 to 28,

drew, according to *Museum News*, an unexpectedly large attendance. More than 200 members were registered, of whom 150 were from out of town and 70 from east of the Mississippi. Three members came from Honolulu and two from Canada. It is reported in the *News* that the meeting was marked by especially successful entertainment features and by a generous spirit of hospitality on the part of the San Francisco museums and their friends and of officials of the Golden Gate International Exposition.

Dr. Clark Wissler, curator of anthropology and dean of the scientific staff of the American Museum of Natural History, was reelected president of the association, and Henry Butler Allen, director of the Franklin Institute, was elected a vice-president, succeeding Frank B. Jewett.

Section chairmen were elected as follows: Art Museums Section, George H. Edgell, director, Museum of Fine Arts, Boston; Art Technical Section, Francis Henry Taylor, director, Worcester Art Museum; Children's Museums Section, Mrs. Dean C. Osborne, president, the Auxiliary, Brooklyn Children's Museum; Education Section, Charles Russell, curator, Department of Education, American Museum of Natural History, New York; National and State Parks Section, Ned J. Burns, chief of the Museum Division, National Park Service, Washington, D. C.; Public Relations Section, Daisy Weld Warner, director of Publicity and Radio, Cleveland Museum of Art; Registrars Section, Imogene C. Robertson, registrar of the Buffalo Museum of Science; Science Museums Section, Carlos E. Cummings, director of the Buffalo Museum of Science; Science Technical Section, Ottmar F. von Fuehrer, staff artist, Carnegie Museum, Pittsburgh; Superintendents Section, Albert N. Henricksen, superintendent of the Brooklyn Museum, New York.

At the invitation of the museums of Detroit, Mich., that city was chosen as the meeting place for 1940.

THE AMERICAN PUBLIC HEALTH ASSOCIATION

THE sixty-eighth annual meeting of the American Public Health Association and meetings of related organizations will open at Pittsburgh, Pa., on Sunday, October 15, closing on Friday, October 20. Thirty-five hundred health officers, nurses, engineers, school physicians, laboratory directors and other specialists are expected to attend. Every state in the Union, Canada, Cuba and Mexico, and many European countries will send delegates to participate in a scientific program that will cover the official public health activities of the North American continent.

The Sixth Institute on Public Health Education will open on Sunday, October 15. The meetings of the institute continue on Monday, October 16, at which time there will meet the International Society of Medical Health Officers, the American School Health Association, the Association of Women in Public Health and the National Organization for Public Health Nursing. The following conference groups also convene on Monday: the State Laboratory Directors, the State Sanitary Engineers, the Municipal Public Health Engineers, the Directors of Local Health Service and the State Directors of Public Health Nursing. Other organizations meeting during the week are the Pennsylvania Public Health Association, the Tri-State Food and Health Officials, the American Social Hygiene Association, Delta Omega and the American Association of State Registration Executors.

There will be six general sessions of the Public Health Association during the week at which "Medical Care," "Cancer," "Professional Education" and "The American Way as Seen from Abroad" are among the subjects to be discussed. The ten sections of the association have arranged an extensive series of joint and individual meetings covering topics of interest to health officers, laboratory workers, vital statisticians, industrial hygienists, public health engineers, food and nutritionists, child hygienists, public health education experts, epidemiologists and public health nurses. There will be a Health Exhibit with commercial and scientific displays. The headquarters will be at the William Penn Hotel. The preliminary program has been reprinted from the August issue of *The American Journal of Public Health* and may be obtained from the American Public Health Association, 50 West 50th Street, New York, N. Y.

SCIENTIFIC NOTES AND NEWS

M. HENRI PIÉRON, professor at the Collège de France and director of the Institute of Psychology of the University of Paris, was elected at the Liège meeting president of the French Association for the Advancement of Science.

OWING to the early adjournment of the Dundee meeting of the British Association for the Advancement of Science Dr. Isaiah Bowman was presumably unable to give the first British and American Association lecture. The lecture, which is entitled "Science and Social Pioneering," will be printed in SCIENCE.

ON the occasion of the seventh assembly of the International Union of Geodesy and Geophysics, at a special convocation on September 11, Washington University conferred the honorary degree of doctor of science on Dr. Dan La Cour, director of the Danish Meteorological Institute, Copenhagen, who was president, and on Brigadier Harold St. John Loyd Winter-

botham, British geologist and geophysicist, general secretary of the union. The degree conferred on Brigadier Winterbotham was *in absentia,* he having been recalled to England on account of the international situation.

THE American Congress of Physical Therapy meeting in New York City awarded on September 6 gold keys to four physicians in recognition of distinguished accomplishments in physical therapy. The presentation was made by Dr. William Schmidt, president of the congress. The awards were to Dr. Edward C. Titus, of New York, for his research in electrotherapy and light therapy; to Dr. A. Bern Hirsh, of New York, for his organization of physical therapy departments in hospitals and clinics; to Dr. Joseph Rivière, of Paris, for the introduction of electro-surgery into medical practice, and to Dr. James B. Mennell, of London, for contributions to physical medicine, particularly in massage.

THE American Amaryllis Society has awarded one of the William Herbert medals for 1939 to A. B. Stout, curator of education and laboratories at the New York Botanical Garden, for his work in breeding, cytology, genetics, introduction of new wild types and the production of fine horticultural varieties of Hemerocallis.

AT Syracuse University the establishment of three pioneer medals "in recognition of outstanding achievements" has been made possible by funds provided by George Arents, vice-president of the Board of Trustees. Dr. William Martin Smallwood, chairman of the department of zoology, was one of the first three recipients of the award. Dr. William P. Graham, chancellor of the university, made the following citation: William Martin Smallwood, distinguished educator; holder of degrees from Syracuse and Harvard; instructor and professor at Allegheny and Syracuse; eminent zoologist; member of various learned societies; author of widely used texts on biology; valued counselor on matters educational; pioneer investigator of the early teaching of science in the United States; donor of the Smallwood Library, an unmatched collection of books which have guided the development of science teaching in this country; for these and other reasons you are cited to receive a George Arents Medal for excellence in science.

F. T. LLEWELLYN, who retired on June 1 as research engineer of the United States Steel Corporation of Delaware after nearly fifty years' service, has been presented with an engrossed resolution of appreciation for his contribution to the structural steel fabricating industry by the American Institute of Steel Construction.

DR. LEONARD CARMICHAEL, since 1938 president of Tufts College, previously professor of psychology at Brown University and at the University of Rochester, was elected at the recent meeting at Berkeley, Calif., president of the American Psychological Association. He succeeds Dr. Gordon W. Allport, assistant professor of psychology at Harvard University.

DR. ROBERT P. FISCHELIS, secretary and chief chemist of the Board of Pharmacy of the State of New Jersey, was elected chairman of the Conference of Pharmaceutical Law Enforcement Officials, at the annual meeting held in Atlanta, Georgia, on August 24.

DR. WILLIAM HOPKINS CRAWFORD has been appointed dean of the School of Dentistry of Indiana University.

DR. ROBERT T. LEGGE, professor of hygiene at the University of California, who resigned as university physician a year ago and who has been on leave for the past twelve months, will return to the department of hygiene to continue his teaching and research on industrial hygiene.

MARGARET I. PINKERTON, superintendent of nurses at Barnes Hospital, St. Louis, has been made dean of the School of Nursing at Duke University, Durham, N. C.

DR. LEE T. SMITH, chemist in the research laboratories of the Bureau of Dairy Industry of the U. S. Department of Agriculture, has been selected to be head of the carbohydrate and derived products division of the Eastern Regional Research Laboratory of the Bureau of Agricultural Chemistry and Engineering. He will direct investigations concerned with the development of new uses of milk sugar and potato starch and products which can be prepared from these materials by fermentation and other means.

THE *Journal* of the American Medical Association reports that, pursuant to a law passed by the 1939 legislature, Governor Bushfield, of South Dakota, has appointed a basic science board. The members are: James D. Alway, Aberdeen; F. E. Burkholder, Sioux Falls; M. L. Severence, Aberdeen; Dr. William H. Waller, professor of anatomy of the School of Medicine at the University of South Dakota, and Dr. Gregg M. Evans, professor of chemistry and physics, Yankton College.

LIEUTENANT COLONEL L. T. POOLE, assistant professor of pathology at the Royal Army Medical College, England, has been promoted to the rank of colonel and has been appointed director and professor of pathology at the college in succession to Major-General H. M. J. Perry, who is retiring.

DR. EVARTS A. GRAHAM, Bixby professor of surgery at the School of Medicine of Washington University,

St. Louis, served this summer as head of the teaching surgical unit at St. Bartholomew's Hospital, London.

THE British Medical Research Council has appointed Dr. Donald Hunter, physician to the London Hospital, and Harold E. Clay, national secretary of the Passenger Services Group, Transport and General Workers' Union, to be members of the Industrial Health Research Board, in succession to Professor J. A. Nixon and R. Coppock.

THE status of director of the British Royal Air Force Medical Services has been advanced to that of director-general with the rank of air-marshal. Air Marshal Sir Albert Richardson, director of the medical services, thus becomes director-general.

DR. JOHN LAWRENCE, assistant professor of medicine at the University of California, a passenger on the British liner *Athenia,* is reported to have been rescued. Dr. Lawrence is a brother of Dr. Ernest O. Lawrence and a son of Dr. C. G. Lawrence, president emeritus of Northern State Teachers College, Aberdeen, S. D.

SIR FREDERICK BANTING, professor of medical research at the University of Toronto, has enlisted as captain in the fifteenth General Hospital of the Canadian Army Medical Corps.

DR. GEORGE S. AVERY, JR., professor of botany at Connecticut College and director of the Connecticut Arboretum, will return this month from the Carlsberg Laboratory in Copenhagen. He has been working with Professor K. Linderstrøm-Lang on enzyme micromethods and hormone-enzyme relationships.

DR. STACY R. METTIER, associate professor of medicine in the Medical School of the University of California, at San Francisco, has returned after spending six months in making a study of diseases of the blood in various clinics in London and elsewhere in Europe.

CHARLES B. HUNT, of the U. S. Geological Survey, has returned from his fourth field season in the Henry Mountains, Utah. Thomas A. Hendricks and Paul Averitt have returned from field work in the Ouachita Mountains, Okla. François E. Matthes has returned from a short field season devoted to the study of glacial deposits and physiography in the eastern Sierra Nevada. Mr. Matthes attended the meeting of the Geological Society of America at Berkeley from August 8 to 10 and, after the meeting, conducted an excursion in the Sierra Nevada.

THE eighth Congress of the Institut International d'Anthropologie was to have met at Istanbul from September 18 to 25 under the presidency of Professor E. Pittard of Geneva. Sections were planned covering paleontology and archeology, physical anthropology, heredity and blood groups, social anthropology, linguistics and the history of religions.

APPLICATIONS must be on file with the United States Civil Service Commission at Washington, D. C., not later than October 2 for the positions of senior aquatic physiologist at a salary of $4,600 a year and of associate aquatic physiologist at a salary of $3,200 in the Fisheries Service, Department of the Interior.

A STUDY of "The Place of Mathematics in Secondary Education" has been completed by the Joint Commission appointed in 1937 by the Mathematics Association of America and the National Council of Teachers of Mathematics, under the chairmanship of Dr. K. P. Williams, head of the department of mathematics of Indiana University. It has been carried on under a financial grant made by the General Education Board and will be published early in 1940 as the year-book of the National Council of Teachers of Mathematics. Members of the Joint Commission representing the Mathematics Association are: Professor Williams, A. A. Bennett, Brown University; H. F. MacNeish, Brooklyn College; H. E. Buchanan, Tulane University; U. G. Mitchell, University of Kansas; C. A. Hutchinson, University of Colorado, and F. L. Griffin, Reed College, and, representing the National Council, W. D. Reeve, Columbia University; William Betz, Rochester, N. Y., public schools; W. L. Hartung, University of Chicago; J. A. Nyberg, Hyde Park High School, Chicago; Mary A. Potter, Racine, Wis., public schools; G. H. Jamison, Northeast Missouri State Teachers College, and Ruth Lane, the State University of Iowa.

IN accordance with a resolution passed by the Board of Directors of the American Chemical Society at the Baltimore meeting, the chairman, Dr. Thomas Midgley, Jr., has appointed the following committee to formulate requirements for chemists in clinical laboratories and report to the directors: Frank C. Whitmore, *chairman,* Gustavus J. Esselen and Robert A. Keho. Any one interested in clinical laboratory work and in the proper qualifications for individuals directing or performing chemical work is asked to transmit his ideas to the chairman of the committee. *Industrial and Engineering Chemistry* states that the earlier notice on this subject is bringing in from the secretaries of the local sections and their members part of the information needed. While there is an interest in all clinical laboratories, special importance at this time is to be placed on any information regarding the quality of chemical work for which the public is paying the members of the medical profession in connection with the diagnosis of disease by the latter. It is stated that the preliminary results of the survey seem to indicate that most work of this kind is done by individuals having practically no chemical training. Those having pertinent information or knowing of others who may be able to give such information are requested to write to Dr. Frank C. Whitmore, State College, Pa.

THE expedition led by Dr. Cecil Madigan across the Simpson Desert in Australia has returned to Adelaide after an absence of three months. Dr. Madigan said, according to the London *Times*, that he could not hold out much hope that the desert country was capable of development as pasture land or for any other purpose, though he did not think that there was danger that the desert would increase in area.

THE Case School of Applied Science has received a grant from the National Advisory Committee for Aeronautics for a basic aerodynamic investigation of boundary layer control to study the effect of air upon the drag of airplane wings. Preliminary studies by Dr. John R. Weske have shown the possibility of reducing the wind resistance of airplanes through such a study.

FUNDS were appropriated in the third deficiency act for the investigation of strategic mineral deposits this year by the Geological Survey in accordance with the authorization, which had been previously passed by congress. These funds became available August 10, and the Geological Survey now has parties investigating strategic mineral deposits in several of the western states. These include manganese deposits in Montana, Washington, Oregon and New Mexico; chromite in Montana, Oregon and Wyoming; tungsten in Nevada; quicksilver in California, Oregon and Idaho; tin in Alaska, South Dakota and New Mexico; and nickel in Alaska. Investigation of certain tin and mica deposits in the southwestern states will begin shortly. Some of these investigations are essentially a continuation of those begun in the summer of 1938. The entire program is expected to continue for four years.

DISCUSSION

A SELF-LIMITING MECHANISM IN SYMPATHETIC HOMEOSTATIC ADJUSTMENT

IT has been shown that adrenaline exercises a specific inhibitory action on sympathetic synapses.[1, 2] This has been demonstrated by recording the decrease in action potentials in the post-ganglionic nerves of the superior cervical ganglion of cats and rabbits when adrenaline was either liberated from the adrenals by splanchnic stimulation or was injected intravenously in amounts comparable to those known to be secreted under stress.[3] In each case as the adrenaline was destroyed recovery from inhibition took place.

It may appear paradoxical that adrenaline, which promotes sympathetic activity, also inhibits it, but I wish to suggest that a beneficial effect, important to the body economy, is served by the opposed actions. The ganglionic inhibitory action of adrenaline may constitute a self-limiting mechanism capable of checking the wide-spread activity produced by sympathico-adrenal discharge when this has reached a high level. The attempt to preserve maximum efficiency in the face of environmental change, *i.e.*, to maintain homeostasis, calls forth a marked, diffuse increase in sympathetic activity. This initiates the following sequence of events: Adrenaline liberated by the augmented splanchnic impulses prolongs and greatly enhances sympathetic activity. If this tends to become excessive, thereby partially defeating its purpose, the concentration of adrenaline in the blood rises to a level sufficient to produce ganglionic inhibition, and thus decreases the sympathetic discharge by obstructing the passage of impulses from the pre- to the post-ganglionic neurones. It may be supposed that a block is also interposed at the neuroadrenal junction, since it is structurally and pharmacologically of a ganglionic nature. The output of adrenaline is thus curtailed. With the lowered concentration of circulating adrenaline ganglionic inhibition is removed. Then, if the need for homeostasis still persists, sympathetic activity is once more allowed full play, until again restrained by the self-limiting influence of the rising blood adrenaline. This automatic safeguard adds another means of adjustment to the regulation exercised by other compensatory mechanisms, such as the carotid sinus.

Additional support for this view is found in the work of Tournade and Chabrol,[4] who observed a restrictive effect on sympathetically controlled functions in adrenalectomized recipient dogs when adrenaline is injected into the donors to which they are joined by adrenojugular anastomosis. Similar and more extensive effects are obtained in the same type of experiment when adrenaline is introduced into the donor by slow, continued infusion.[5] The inhibitory effects of adrenaline on the pressor action of nicotine and on reflexly induced sympathetic responses, described by Hoskins and Rowley[6] in 1915, are susceptible in part to a similar interpretation. So are the results of more recent workers,[7, 8] who have studied the depression of reflex sympathetic phenomena by adrenaline.

[1] A. S. Marrazzi, *Jour. Pharmacol. and Exp. Therap.*, 65: 395, 1939.
[2] *Ibid.*, *Proc. Amer. Physiol. Soc.*, page 163, April, 1939.
[3] W. B. Cannon and D. Rapport, *Amer. Jour. Physiol.*, 58: 308, 1921.
[4] A. Tournade and M. Chabrol, *C.R. de la Soc. de biol.*, 94: 535, 1926.
[5] J. Malmejac, V. Donnet and E. Desanti, *C.R. de la Soc. de biol.*, 119: 1152, 1935.
[6] R. G. Hoskins and W. N. Rowley, *Amer. Jour. Physiol.*, 37: 471, 1915.
[7] L. W. Chu and F. Y. Hsu, *Quart. Jour. Exp. Physiol.*, 27: 307, 1938.

Were it not that the ganglionic nature of the neuro-adrenal junction prevents excitation of the adrenal by its own secretion,[9] adrenaline secretion once started might be self-perpetuating. Instead the nature of the junction introduces the possibility of self-limitation of adrenal discharge by the ganglionic inhibitory action of adrenaline. Work in progress is expected to yield data that will further test this view.

AMEDEO S. MARRAZZI

NEW YORK UNIVERSITY
COLLEGE OF MEDICINE

CHLORAZOL FAST PINK BKS

IN the April 14 issue of SCIENCE there is a communication from Dr. Walter Modell drawing attention to the valuable characteristics of the azo dye known as Chlorazol Fast Pink BKS, Color Index No. 353, as an anti-coagulant.

This dye has been prepared in a pure form under my direction for quite a number of years in order to save the biological laboratory the necessity of purification, and has been supplied free of cost, in small quantities, to institutions of learning. Dr. Charles E. King, of Vanderbilt University, states that the material, as furnished, is so little toxic that he is able to give a full dose in one injection, although the slight shock, when this is done, can be avoided by dividing the amount and giving it in three portions.

This communication is made to inform those interested that, if they are in need of very small quantities, they can obtain these without the necessity of doing their own purification.

R. E. ROSE

E. I. DU PONT DE NEMOURS AND COMPANY,
WILMINGTON, DEL.

"STARS" IN AMERICAN MEN OF SCIENCE

IN the "Distribution of the Younger Starred Scientists" by Professor S. S. Visher, which recently appeared in SCIENCE,[1] occurs the following statement: "Universities which had fewer starred men on their faculty in 1938 than in 1906 include Columbia, 60 in 1906, 39½ in 1938; Cornell 33, 25½; Dartmouth 6, 1; New York 9, 7; Clark 7, 1; Indiana 6, 3; Missouri 9, 1; Wesleyan 7, 4."

The casual reader would infer that these faculties had deteriorated or at least lost many of their most talented or creatively industrious members. A little further examination, however, reveals that the article contains no data as to actual numbers in 1938. In lieu of actual numbers for each institution, the article takes the total numbers of new names starred in 1921-1937 (third to sixth editions), mistakes them for totals on these faculties in 1938, and, comparing them with totals for 1906, finds in this particular group of institutions "fewer starred men" than in 1906.

As a simple and modest example, Dartmouth (which still prides itself on being a "liberal college" with no university aspirations) had in 1906 six starred members and actually six (rather than one as stated) in 1938. If an interested person should take the trouble to look up in the recent edition of American Men of Science the 1938 numbers for other institutions with diminishing returns, some of them, too, very likely would be removed from the black list.

A similar confusion appears in the two preceding paragraphs. The number of starred men included in the 1906 selection of 1,000 is compared with the total for each institution of selections in 1921, 1927, 1932 and 1937 (*ca.*, another 1,000). A list of institutions is given in which these total subsequent selections approximately equal the original selection for that institution: *e.g.*, Harvard 66 in 1906, compared with 69 (inadvertently identified with the unascertained number on the faculty in 1938).

Another list of institutions which have "gained notably" includes California, 27 in 1906 compared with 39, which is wrongly assumed to be the unascertained number on the faculty in 1938, but really is the total of the four selections made during the past 18 years.

If all the men and women starred in 1906 had died, or somehow become completely annihilated, before 1938, Professor Visher's statistical interpretation of the selections made during the last two decades would have been approximately correct.

J. H. G.

DARTMOUTH COLLEGE

THE portion of an article on this subject reprinted in the June 23 issue (89: 583–585) contains two inadequate statements. Although the study is concerned with the younger starred scientists, those starred in 1921–1937, and refers to the older group (those starred in 1903 or 1909) only for sake of comparison, a statement on the 1938 distribution of starred scientists does not make this limitation clear. What was meant was that certain institutions had in 1938 or earlier of the 1,101 scientists starred in 1921–1937 the numbers specified, which totals were greater or less than those institutions had of the 1,000 starred in 1903. A very few of these older men have not yet retired, whereas the quoted statements imply that they have all died or retired.

STEPHEN S. VISHER

THE PACIFIC ENTOMOLOGICAL SURVEY

A NOTE under this heading in SCIENCE for June 16, 1939, over several signatures from Hawaii, has been

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[8] C. W. Darrow and E. Gellhorn, *Proc. Amer. Jour. Physiol.*, page 58, April, 1939.

[9] P. Trendelenburg, *Ergebn. der Physiologie*, 21: 549, 1923.

[1] SCIENCE, 89: 583–585, June 23, 1939, reprinted (abridged) from *American Journal of Science*, 237 (1): 48–65, January, 1939.

rought to my notice by B. Ewart White, of 36 Bedord Row, London, W.C.1., in a letter to me dated uly 12.

Exception is taken to the statement that E. P. Mumord, who has been completing the Marquesan work nder my general supervision, has "no control over e collections made in the Marquesas" by himself and is assistants "nor over the publications resulting from eir study," and that "All correspondence pertinent the original survey" (which Mr. Mumfo.d had been vited to direct, and towards the completion of which rough the depression he and others outside of awaii had contributed financially) "should be addressed to Bernice P. Bishop Museum, Honolulu."

The facts are that the director of that museum had imself stated in official letters to Mr. White, "I underand perfectly that Mr. Mumford is responsible for ecking the remaining taxonomic papers on the maerial collected by him and his assistants in the Marquesas and Society Islands." Mr. White continues: he balance of funds on hand to the credit of the acific Entomological Survey in Hawaii in 1936 was ansferred to me by order of the benefactors in awaii and elsewhere, and . . . I, as representative these and subsequent subscribers, have here in safe eeping the original authorizations from Honolulu eferring to the continued use of Pacific Entomological urvey Notes, correspondence, etc., and to the *conuation* of the 'work under the name of the Pacific ntomological Survey.'"

The statement in SCIENCE that the work now being arried on by Mr. Mumford under the auspices of xford University is a "new 'Survey' . . . distinct rom the survey organized in Hawaii," is misleading. he authors of that statement make no reference to e account in the leading English scientific periodical *'Nature,'* January 29, 1938, of the means by which Mr. Mumford's work was continued at Oxford.

The reference to registration of a Pacific Entomological Survey "with headquarters at Oxford" is equally misleading. In 1936 a custodian of the abovementioned funds was necessary, and Mr. B. Ewart White consented to serve as a trustee. The name Pacific Entomological Survey was used for the time being to maintain the continuity of the work, as stated above, but the name Pacific Entomological Survey has not been, and will not be, employed in connection with the present phase of the work associated officially with Oxford.

It is to be deplored that attempts to interfere with the progress of this work should be made, even under a misapprehension. The only object in view should be to obtain, and make known, facts which will help in elucidating the problems of the Pacific Islands. It is appreciated by us that the Marquesan collections and certain other material now under the charge of Mr. Mumford will be deposited in the Bernice P. Bishop Museum, when the final results have been obtained. To further this end the Hope Department of Entomology of the University of Oxford, by means of grants from the University for five years from October, 1938, from the Royal Society and the British Association for the Advancement of Science and from benefactors through the trustee, Mr. B. Ewart White, is obtaining from sundry little known islands in the Pacific, new collections which it is hoped will aid in elucidating problems revealed by the Marquesan work that Mr. Mumford has been completing at Oxford.

G. D. HALE CARPENTER,
Hope Professor of Zoology (Entomology) in the University of Oxford

JULY, 1939

SCIENTIFIC BOOKS

ELEMENTARY MATRICES

lementary Matrices and Some Applications to Dynamics and Differential Equations. By R. A. FRAZER, W. J. DUNCAN and A. R. COLLAR. xvi + 416 pp., 8vo. Cambridge: at the University Press. New York: The Macmillan Company.

Two of the authors of this beautifully printed volme are members of the Aerodynamics Department of he National Physical Laboratory of England, and the hird is professor of aeronautics at Hull.

The book appears to have three main objectives. he first is the development of certain phases of elementary matric theory, the second is the practical olution of differential equations by means of the atric calculus, and the third is the application of hese methods to mechanics, in particular to the ynamics of the airplane.

Clearly the book is intended primarily for students of applied mathematics who are not very familiar with modern algebra. Consequently, the elementary treatise on matrices which occupies the first 155 pages is quite lengthy and detailed. The usual theorems are given on quadratic and bilinear forms, latent (characteristic) roots, elementary operations and the elementary divisor theory. Infinite series of matrices are also treated and matrices of differential operators.

Throughout the text, computational methods are featured and many numerical problems are worked out in detail. Much attention is given to rapid methods of calculation by means of machines. For example, more than twenty pages are devoted to methods for calculating the reciprocal of a matrix, and one specimen calculation of the reciprocal of a sixth order matrix is given with some elements computed to the ninth deci-

mal place. The solution of linear systems of algebraic equations is treated from the same standpoint, specimen solutions exhibiting methods which reduce labor to a minimum. Methods involving matrices are used to obtain dominant roots of algebraic equations of higher degree. Here the methods are interesting, but the results are not spectacular from the standpoint of the saving of labor.

After the four introductory chapters comes the treatment of differential equations and systems of differential equations by matric methods. While these methods are not essentially new, it is probably correct to say that this book takes more pains than any previous one to develop the theory in an elementary manner, and by means of many specimen problems to bring the methods within the range of the great number of workers who use differential equations in a practical way.

One interesting point in the matric method is its connection with the operational calculus of Heaviside. Some of the successful but unreasonable empirical methods which so delighted Heaviside appear quite reasonable and rigorous from the matric approach.

Next come chapters on kinematics and dynamics of systems, and systems with linear dynamical equations. The treatment is conventional, except that matric methods are used wherever possible, mainly in the solution of the differential equations involved, and that most of the problems relate to aerodynamics.

Chapter X is a collection of problems, each of considerable intrinsic interest, which are worked out in detail and with the expenditure of considerable labor. These problems are: (1) Oscillations of a triple pendulum. (2) Torsional oscillations of a uniform cantilever. (3) Torsional oscillations of a multi-cylinder engine. (4) Flexural oscillations of a tapered beam. (5) Symmetrical vibrations of an annular membrane. (6) A system with two equal frequencies. (7) The static twist of an aeroplane wing under aerodynamical load. (8) The oscillations of a wing in an airstream.

The remaining three chapters are devoted to the dynamics of the airplane, and in them some problems of considerable difficulty and practical importance are worked out by the techniques discussed earlier. The phenomena of ankylosis (or "sticking" of a degree of freedom), and flutter are treated at length with numerical problems and graphic interpretation of results. The last chapter is on pitching oscillations of a frictionally constrained aerofoil.

Judged by American and Continental standards, the book is verbose and somewhat nationalistic in referring to other authors. But clearly the book was written in the hope of converting many applied mathematicians to the use of more elegant and powerful mathematical tools, and it is so skilfully and attractively designed for this purpose that one should judge it from no other angle.

C. C. MACDUFFEE

UNIVERSITY OF WISCONSIN

SOCIETIES AND MEETINGS

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

IN response to the kind invitation of the University of Liège, the French Association for the Advancement of Science met from July 17 to 22 for the third time in Belgium; the previous meetings were at Liège in 1924 and at Brussels in 1932.

The International Water Exhibition at Liège which marked the inauguration of the Albert Canal gave the meeting a special interest. Professor C. Fabry, president of the French Association, presided over the meeting, and Professor Dehalu, *administrateur-inspecteur* of the University of Liège, was president of the local committee.

The opening ceremony toook place on July 17 in the hall of the university. Professor Dehalu expressed his pleasure at receiving the Association at Liège for the second time, and Senator Buisseret, speaking on behalf of the burgomaster, welcomed the members of the congress. Professor C. D. Ellis, Wheatstone professor of physics at King's College, London, representing the British Association, and Dr. C. Romaña, representing the Argentine Association for the Advancement of Science, brought messages of good will for the success of the meeting. Professor Fabry, after having expressed the thanks of the association to the local committee at Liège, delivered his presidential address, on interstellar space.

Professor Fabry showed how a profound study of the light of the stars has enabled us to detect, in interstellar space, matter in a state of extreme rarefaction (1 kgm, nearly in a volume equal to that of the earth). In addition to matter, there exists also in interstellar space energy in the form of radiation emitted by the stars. These results have demonstrated the fruitfulness of collaboration of diverse scientific disciplines and of pure and applied science. Such collaboration is also the object of the French Association and of similar bodies.

The scientific meetings were held in the magnificent Institutes of Civil Engineering and Chemistry of the University of Liège at Val Benoît on July 17 and the following days. July 19 was devoted to an excursion on the Albert Canal and to a visit to a colliery at Beeringen. July 21, the day of the national fête of

[1] From *Nature*.

Belgium, was taken up with a visit to the Water Exhibition.

The several sections of the association showed great activity. The question of water occupied a prominent place in the program and was the subject of the following papers: M. Wyart, the states of solid and liquid water studied by x-rays; M. Cabannes, the Raman spectrum of liquid water; M. Kraft de la Saulx, history of the construction of hydraulic machines; M. Tongas, thermodynamic properties of steam; M. Trochon, microphysics of mists considered as aerosols; M. Roulleau, hygrometry; M. Rocard, kinetic theory of liquids; M. Hubault, pollution of waters, their industrial utilization and modifications of their fauna.

The Section of Civil and Military Engineering, under the presidency of M. Campus, was divided into three subsections: theoretical and applied hydraulics; navigable channels and ports; hydraulic works. One session was devoted to colonial hydrography.

The Section of Physics heard communications, among others, from Professors F. Joliot and F. Perrin. The work of the Section of Geology was completed by field excursions; the Section of Botany also had excursions in which the Royal Society of Botany of Belgium and the Liège Botanical Circle joined.

The Sections of Biogeography and of Zoology held several joint sessions with papers on the biology of equatorial lakes (M. Damas), the relations between the internal and external media in aquatic animals (M. Florkin) and the phreatic fauna (M. R. Leruth).

Mention should also be made of the communications presented to the Section of Geography (streams, their utilization and management, demographic and social aspects of water); and to the Sections of Medical Sciences (metabolism of water), of Psychology and Pedagogy, of Radiology and of Odontology.

Special subsections considered technical applications of water, applications of electricity, archeology and folklore.

The communications presented at the meeting will form a special volume published in connection with the Liège meeting.

THE MEDICAL LIBRARY ASSOCIATION

THE Medical Library Association held its forty-first annual meeting from June 27 to 29, 1939, at the Academy of Medicine of Northern New Jersey, Newark. Officers for 1939–40 are: *President,* Colonel Harold W. Jones, Washington, D. C.; *Vice-president,* Dr. John M. Armstrong, St. Paul; *Secretary,* Miss Anna C. Holt, Boston; *Treasurer,* Miss Louise D. C. King, Baltimore; *Chairman of the Executive Committee,* Miss Mary Louise Marshall, New Orleans.

Miss Linda H. Morley described the varying services and requirements of three general types of medical libraries: those serving educational institutions; those serving organizations, and those affiliated and housed with a particular organization's staff.

Dr. George H. Lathrope answered the question, "Why Medical History for the Medical Librarian?" First, one's patrons are growing interested in this subject; second, it is a pleasant aid in developing acquaintance with medicine and its terminology; third, it has a distinct cultural value; and fourth, medical history is an almost untouched field for research.

"The Hospital Library and Its Administration" formed the subject of a most useful paper by Miss L. Margueriete Prime. She showed how the medical profession and friends of medical libraries have developed good hospital libraries. Standards have been established for them by the American Medical Association, the Canadian Medical Association and the American College of Surgeons. A general discussion of the organization and administration of the hospital library followed.

Another phase of the library connected with the hospital was portrayed by Miss Ethel Wigmore in her discussion of "The Responsibility of the Medical Library to the Nursing Profession." After sketching the development of libraries for nurses, with special reference to Bellevue, Miss Wigmore drew a picture of their present status in nursing education and of the growth of nursing literature.

Miss Margaret Bates showed in lantern slides a most interesting series of medical postage stamps.

Dr. Karl M. Scott gave a paper on "The Literature of Syphilis," in which he presented a broad picture of the whole subject and its application to the present-day campaign for control of the disease.

Real assistance in the association's endeavor to enlarge its supporting membership was rendered by Dr. Arthur H. Sanford, of the Mayo Clinic, who described the mutual benefits to be secured thereby. Dr. Joseph E. Raycroft's discourse on "Old Wine in New Bottles" quoted writings and archeological records to show that the ancients used certain treatments which are still valuable.

Dr. Max E. Soifer discussed "Dr. Horace Wells, the Discoverer of Anesthesia." "Problems of Microphotography," by Miss Dorothy Hale Litchfield and Dr. Mary A. Bennett, of the Film Library of Columbia University, dealt with the making, use and care of microfilms in libraries.

Dr. Charles H. Young made most interesting his account of the benefits and dangers of aviation to mankind. Aviation medicine is really preventive medicine.

The 1940 annual meeting of the association will be held in Portland, Oregon, at the invitation of the University of Oregon School of Medicine.

ANNA C. HOLT,
Secretary

SPECIAL ARTICLES

RADIOACTIVE ION EXCHANGES IN LIVING PROTOPLASM

PENETRATION curves for the entrance of radioactive ions into living cells of *Nitella coronata* have been described by Brooks,[1] who has also suggested that the initial increase in ion concentration in protoplasm during the first phase, which is at a maximum in about 15 minutes, is due to an exchange of a radioactive ion for some inactive ion. In the present study, the loss of radioactive ions from the protoplasm of *Nitella* by means of exchange was investigated. Ion exchange is here used to connote the replacement of an ion, possibly bound to an electrolyte by another ion. Ion exchange studies on barley roots have been described by Jenny and Overstreet[2] and on *Elodea* by Mazia.[3]

Nitella were taken from large outdoor ponds, separated into single cells and allowed to remain in pond water at 10° C. for a week. Only turgid cells with a length of 3.5 to 4.5 cm were used, in order to secure material which was as uniform as possible. Cells were immersed in 0.01 M solutions of K*Cl or Na*Cl dissolved in pond water at pH 8.2. After 15 minutes the cells were removed from the radioactive solutions, washed in triple distilled water, and the number of radioactive impacts measured with a Geiger-Müller counter. Cells were then placed in 0.01 M solutions of either LiCl, NaCl, KCl, RbCl or CsCl. Cells placed in either quartz-distilled CO_2-free water or in an ion-free 0.02 M sucrose solutions were used as controls. The temperature was $15 \pm 0.1°$ C. After a 15-minute immersion, measurements of radioactive counts on each cell were made after 1, 2, 3, 5 and 10 minutes. Whole cells were used, the method of measuring consisting simply of placing each cell on a glass slide and putting this slide a known distance from the Geiger-Müller counting tube. The cell could then be returned to its solution and subsequent loss of radioactivity followed. There is no error because of the presence of sap, since there is no loss of Na* or K* to the sap as shown by separate analyses of the sap, protoplasm and wall in 15 minutes. The curves for the loss of radioactive ions from *Nitella* were exponential and followed equation (1)

$$C_p = C_o e^{-kt}, \qquad (1)$$

where C_p is the concentration of radioactive ion in the protoplasm, C_o the initial concentration of ions in the protoplasm, k a constant giving the slope of the logarithmic curve and t the time of immersion of the cell in the solution of inactive ion. The values of k which were found are given in Table I, and they represent the rate of loss of ions from the cell.

TABLE I

Ion Exchanged	Value of k for Li	Na	K	Rb	Cs	HOH
Na*	0.33	0.26	0.23	0.20	0.19	0.05
K*	0.12	0.16	0.83	2.00	...	0.05

Some preliminary experiments with Rb*Cl and the alkali cation series indicate that in the exchange of Rb* for Li, Na, K, Rb or Cs, the results are similar to those in which K* was used, but the rate of loss is much greater.

Further preliminary experiments on the ion exchange properties of the vacuolar membrane of *Nitella* have been carried out by studying the changes in concentration of either K* or Rb* in both sap and protoplasm after the cell had been immersed in radioactive solutions for 24 hours, to allow for accumulation in the vacuole, and then placed in solutions of inactive alkali cations. The rate of loss of ions from the protoplasm was slower than when the cells had been immersed only 15 minutes. In the sap there was an initial rise after one minute and then a falling off in concentration. In the case of anions, where radioactive phosphorus (as $HPO_4^=$) was used and its exchange for the series F, Cl, Br, I, tested, there is a more rapid loss of P* in F^- than in I^- solutions.

In summary one may say that in the case of K*, the rate of loss followed the Hofmeister series, Rb^+ was the fastest and Li^+ the slowest in replacing K*. For Na* the Hofmeister series was reversed, Li^+ was the most rapid and Cs^+ the slowest in replacing Na*. In distilled water the rate of loss of ions was very low. It is suggested that there are at least two factors in operation, namely (1) a permeability effect which in the case of Na* reverses the lyotropic series because ions may not directly exchange, but, rather, be removed because of a decrease in the number of exchange positions on the membrane, and (2) the lyotropic series which governs the loss of ions from the cell in the case of K*.

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THE DENATURATION OF PROTEINS BY DETERGENTS AND BILE SALTS

ALL the synthetic detergents and bile salts I have tried denature ordinary proteins such as hemoglobin and egg albumin at the isoelectric point and keep the denatured isoelectric protein in solution. Some detergents, such as Duponol PC,[1] in sufficiently high concentration, can prevent the precipitation of denatured protein by trichloracetic acid, tungstic acid and acid ferric sulfate.

Screenivasaya and Pirie[2] observed that the syn-

[1] S. C. Brooks, *Proc. Soc. Exp. Biol. Med.*, 38: 856–858, 1938.

[2] H. Jenny and R. Overstreet, *Proc. Nat. Acad. Sci.*, 24: 384–392, 1938.

[3] D. Mazia, *J. Cell. Comp. Physiol.*, 11: 193–203, 1938.

[1] Sodium dodecyl sulfate is the C_{12} compound of the series $CH_3(CH_2)_nCH_2OSO_3Na$. Duponol Special WA Paste (du Pont) consists mainly of the C_{12} compound. Duponol PC is a mixture of the C_{10}–C_{18} compounds.

[2] M. Screenivasaya and N. W. Pirie, *Biochem. Jour.*, 32: 1707, 1938.

thetic detergent sodium dodecyl sulfate[1] in 0.5 per cent. solution slowly splits the large tobacco mosaic virus protein into smaller molecules and separates the nucleic acid from the protein, but does not denature the protein as shown by solubility and digestibility tests. Unfortunately the tests for denaturation were not carried out in an altogether satisfactory way. In any case, tobacco mosaic virus is much more resistant to sodium dodecyl sulfate than hemoglobin or egg albumin.

Hemoglobin is denatured by extraordinarily small amounts of Duponol PC. The addition of only 2 mg of Duponol PC to 10 mg of beef methemoglobin dissolved in 10 cc of pH 6.8 phosphate buffer solution suffices to denature the protein. This denaturation of methemoglobin in dilute solution can be followed optically. Native methemoglobin is a brown compound with a band in the red. Denatured methemoglobin in neutral Duponol solution is a red compound with no band in the red.

If 0.5 gm of Duponol PC is added to 10 cc of 2.5 per cent. hemoglobin and the excess Duponol is then removed by dialysis against water, the hemoglobin remains in solution after the dialysis and retains the color and spectrum of denatured methemoglobin. This result shows the great affinity of Duponol PC for denatured methemoglobin. The dialyzed hemoglobin is precipitated by 0.1 saturated ammonium sulfate, which does not precipitate native methemoglobin. It is digested by trypsin, which does not digest native methemoglobin. Duponol PC in sufficiently high concentration can prevent the precipitation by 0.1 saturated ammonium sulfate and can inactivate trypsin. This is why the excess Duponol is removed by dialysis before the solubility and digestibility tests.

It takes about 10 times as much of the bile salt, sodium glycholate, as of Duponol PC to denature hemoglobin.

0.2 N trichloracetic acid does not precipitate hemoglobin in 1 per cent. solution if 1.3 per cent. Duponol PC is present.

Hemoglobin can be estimated colorimetrically as denatured methemoglobin in 1 per cent. Duponol PC solution. This colorimetric procedure has two advantages over the usual acid hematin procedure. The amount of light adsorbed does not change with time and it is the same whether the Duponol is added to oxyhemoglobin or to methemoglobin.

Bacteria do not grow in the hemoglobin solution containing 1 per cent. Duponol, not even at 37° C.

The synthetic detergents and the bile salts all have the same type of hydrophobic-hydrophilic structure. Each synthetic detergent and bile salt consists of a large hydrophobic part with a small hydrophilic part attached to it. In actual chemical structure, the detergents and bile salts vary considerably. The hydrophilic group may be an acid group, such as OSO_3^-, or a basic nitrogen group. The hydrophobic part may consist of a long straight fatty acid chain, or it may contain a naphthalene or other ring structure.

The denaturation of protein and the solution of denatured protein by detergents and bile salts which differ widely in chemical composition must be attributed to the one property all the detergents and bile salts have in common, their general hydrophobic-hydrophilic character.

Bile salts have been used to extract the photosensitive protein pigment of the eye[3] and to extract a chlorophyll compound from the chloroplasts of spinach.[4] Chlorophyll, I have found, can be extracted from spinach by Duponol PC much more effectively than by bile salts. It is now clear, however, that a protein extracted by bile salts or detergents may no longer be in its original native undissociated form.

Physiologically, the bile salts emulsify fats, activate lipase and promote the absorption of various substances. The possibility must now be considered that the physiological reactions of the bile salts, like their reactions with proteins, depend not on their specific structures, but on their general hydrophobic-hydrophilic character, and that other substances with the same general hydrophobic-hydrophilic character can act as physiological substitutes for the bile salts.

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THE CONFIGURATION OF THE GLUTAMIC ACID OF ADENOCARCINOMA PROTEIN

RECENTLY, Kögl and Erxleben[1] have reported that the glutamic acid of malignant tumor proteins is present in partly racemized form. Chibnall, Rees, Tristram, Williams and Boyland,[2] using the Foreman procedure, found only l(+) glutamic acid in Crocker mouse sarcoma and in bronchial carcinoma. Kögl and Erxleben[3] have offered evidence to show that the Foreman procedure is unsuited for the isolation of the unnatural glutamic acid isomer (d(−) glumatic acid). It is reported in a recent issue of *Science News Letter* (36:37, 1939) that the results of Kögl and Erxleben have been confirmed by Dr. E. Schroeder, of the Biochemical Research Foundation of the Franklin Institute.

[3] W. Kühne in L. Hermann, "Handbuch der Physiologie," Leipzig, 1879, 3: 264.
[4] E. L. Smith, SCIENCE, 88: 170, 1938.
[1] Kögl and H. Erxleben, *Zeit. f. physiol. Chem.*, 258: 57, 1939.
[2] A. C. Chibnall, M. W. Rees, G. R. Tristram, E. F. Williams and E. Boyland, *Nature*, 144: 71, 1939.
[3] F. Kögl and H. Erxleben, *Nature*, 144: 111, 1939.

Using the method employed by Kögl and Erxleben, we have isolated glumatic acid from two adenocarcinomas of the large intestine, and from a sample of normal intestinal tissue adjacent to one of the carcinomas. Our results indicate that approximately 41 per cent. of the glumatic acid in the first carcinoma, and approximately 26 per cent. of the glumatic acid in the second, were present as d(−) glutamic acid. These findings confirm the report of Kögl and Erxleben. Our experimental data are summarized below:

(1) *Adenocarcinoma of the sigmoid colon.* Initial weight, 97.5 g. Weight of dried combined protein, 14.0 g. Glutamic acid hydrochloride isolated, 97 mg. M. P., 205° C. $[\alpha]_D$, +5.5°.

(2) *Adenocarcinoma of the cecum.* Initial weight, 108.5 g. Weight of dried combined protein, 15 g. Glutamic acid hydrochloride isolated, 140 mg. M. P., 201° C. $[\alpha]_D$, +15.0°.

(3) *Normal tissue adjacent to adenocarcinoma of the cecum.* Initial weight, 150 g. Weight of dried combined protein, 19.1 g. Glutamic acid hydrochloride isolated, 19 mg. M. P., 205° C. $[\alpha]_D$, +31.0°.

It will be noticed that the yield of glumatic acid obtained from the adenocarcinoma of the cecum was considerably greater than that obtained from adjacent normal tissue. No conclusion can be drawn from this, however, since the insolation of the glumatic acid was not quantitative.

We are indebted to the departments of pathology and surgery of the University of Minnesota Medical School for giving us the tissues analyzed immediately after operation. Microscopic diagnoses of the tumors were made by Dr. Robert Hebbel.

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POLIOMYELITIC VIRUS IN SEWAGE

WITHIN the past two years it has become increasingly apparent that poliomyelitic virus may be readily isolated from the stools of human patients during acute and convalescent stages of this disease. Many reports now testify to the ease with which this can be accomplished.[1] Consequently, whenever poliomyelitis occurs within a city, there is at least an opportunity for this virus to enter the local sewage system. But actually poliomyelitic virus has never been demonstrated in sewage, and there is no information as to the possible amounts which may be there, nor the length of time which this virus might survive in this medium.

An opportunity to test this situation has recently occurred in the City of Charleston, South Carolina, where poliomyelitis assumed epidemic proportions during the months of May, June and July of this year. From this same South Carolina epidemic a strain of virus was isolated from a specimen of feces received in our laboratory on July first. The stool was from a child (B.Cr.) three years old, who had contracted paralytic poliomyelitis in a small up-state town, but who had been hospitalized in Charleston. Part of the stool suspension was inoculated intraperitoneally into one rhesus monkey (No. 1213) on July fourth, and typical experimental poliomyelitis resulted after an incubation period of five days. This strain has been successfully carried to its third passage (monkeys No. 1230 and 1242) and is characteristic of poliomyelitic virus.

Subsequently, through the kindness of Dr. L. Banov, health officer of the City of Charleston, samples of sewage were collected by two of us (J. R. P. and J. D. T.) from a few sites throughout the city during the period of July 7 to 14, 1939. Particular attention was paid to one pumping station in which the sewage came not only from the hospital where poliomyelitis patients were isolated, but also from that part of the city where most of the cases had arisen. One sample (C) of this sewage, amounting to about 8 liters in volume, was collected on July 11 in a tall glass bottle and allowed to stand for a period of twenty-four hours. Ice was packed about the base of the bottle for part of this time. After the first two hours, a sample of sediment (C-1) amounting to 200 cc was removed and to it 24 cc of ether were added for bactericidal purposes. This sample was then taken to New Haven, where, on July 12 and 13, 75 and 45 cc, respectively, were inoculated intraperitoneally into one monkey (No. 1227). Another sample (C-2) amounting to 700 cc of the sediment, was removed from the original 8-liter specimen on July 12; 70 cc of ether were added to it, and the specimen was sent to New Haven, where one monkey (No. 1232) was inoculated intraperitoneally with 125 cc on July 14. Both of these animals developed experimental poliomyelitis. The incubation period in monkey 1227 was eight days from the last inoculation, and in monkey 1232 it was seven days. After a brief febrile period both animals developed quadriplegia, and both were prostrate on the third day of their disease. Monkey 1232 died on this day; no. 1227 was sacrificed. Spinal cord lesions, demonstrable histologically, were found to be very extensive in both animals. It is unusual in our experience to see rhesus

[1] (*a*) P. H. Harmon, *Jour. Am. Med. Asn.*, 109: 1061, 1937; (*b*) J. D. Trask, A. J. Vignec and J. R. Paul, *Jour. Am. Med. Asn.*, 111: 6–11, 1938; (*c*) P. Lépine and P. Sédallian, *Compt. rend, Acad. d. sci.*, 208: 129–130, 1939; (*d*) S. D. Kramer, B. Hoskwith and L. H. Grossman, *Jour. Exp. Med.*, 69: 49–67, 1939; (*e*) C. Kling, G. Olin, J. H. Magnusson and S. Gard, *Bull. Acad. méd.*, 121: 826–831, 1939; (*f*) J. R. Paul, A. J. Vignec and J. D. Trask, *Trans. Asn. Am. Phys.* (to be published). Also personal communications from: G. Y. McClure, Division of Laboratories and Research, N. Y. State Department of Health; and from C. Armstrong, National Institute of Health, Washington, D. C.

TABLE 1

TESTS FOR POLIOMYELITIC VIRUS IN SEWAGE SPECIMENS

Sewage specimen	Original amount	Interim between collection and inoculation	Amount of inoculum		Monkey No.	Result
			Intraperitoneal	Subcutaneous		
(A) Pump	3.5 liters	6 and 7 days	36 cc	22 cc	1229	Abscess of abdominal wall; acute peritonitis. Killed on 4th day.
(B) Har.	0.5 liter	7 days	24 "		1231	Chronic and acute peritonitis. Died on 18th day.
(C) Pump (1)	8 liters	1 and 2 days	120 "		1227	Poliomyelitis. Killed on 10th day. Passage to monkey 1248 successful.
(2)		3 days	125 "		1232	Poliomyelitis. Died on 8th day. Passage not done.
(D) Hosp. (1)	7 "	5 "	75 "	125 "	1239	Infected abdominal wall. Died on 2nd day.
(2)		6 "	25 "	46 "	1240	Abscess of abdominal wall. Killed on 4th day.

monkeys develop such a severe form of the experimental disease when inoculated with material from a human source, and so we have suspected that the amounts of virus in the inocula here were not small.

The results of our experiments to date on this type of material appear in Table I. Here it will also be seen that our other attempts to isolate virus from Charleston sewage were unsuccessful as a result of the premature death of the monkey from bacterial infection. Obviously, methods have not yet been perfected for handling or testing this type of material.

Our criteria for the diagnosis of poliomyelitis in these experiments have been practically the same as those we have used in previous work[2] on the isolation of poliomyelitic virus from extra-neural human sources, namely, that the inoculated animal developed signs and symptoms compatible with those of the experimental disease; that typical lesions were found in the spinal cord, and that the strain was successfully passed to another monkey. All these criteria were met in the case of monkey 1227; one of them is omitted in monkey 1232, for a passage of this strain was not attempted.

It is not evident from this work whether the presence of poliomyelitic virus in sewage is a direct or even an indirect link in the chain which leads this infectious agent from one patient to another in this disease. Our report merely calls attention to the fact that poliomyelitic virus may not only be present in urban sewage but also that it may possibly be present in appreciable quantities.[3]

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

DEMONSTRATION OF THE SHAPE OF CILIA IN NORMAL MOTION

IT is often desirable to demonstrate the shape and motion of cilia without the use of methods which may cause distortion or prevent an estimation of the rate of beating. An easily made stroboscope meets this need.

To make a periodically moving object like a cilium appear stationary, it must be made visible repeatedly at only one point in its path. This can be achieved by a light flashing on the object at exactly the same frequency as its motion. If the synchronization is not quite perfect, the cilium will appear to be moving very slowly because each flash of light will reveal it at a slightly different position. Should the synchronization be much poorer, the entire effect will be lost. These principles constitute the basis of the stroboscope.

An obvious means of producing a flashing light is to have a disk with a number of regularly spaced radial slits rotating in front of a fairly strong light source. Four slits have been found most suitable. In projection, it makes little difference where the disk is located; for convenience it may be placed between the ocular and the screen.

A satisfactory method for the adjustment of the disk's speed is an important element in the success of the stroboscope. A rheostat in series with the motor attached to the disk is adequate; however, finer adjustment is obtainable with two rheostats in series if the resistance per unit length of one is considerably larger than the other's. In the way of a motor, even those obtainable in metal construction kits are usable. A possible arrangement of the apparatus is shown in the diagram.

The rate of ciliary motion can easily be determined from the disk's speed when synchronization, as judged from the cessation of movement, is attained. In general, it will be found a simple matter to count the

[2] Criteria reviewed by A. J. Vignec, J. R. Paul and J. D. Trask, *Yale Jour. Biol. and Med.*, 11: 15–31, 1938.

[3] Aided by grants from the National Foundation for Infantile Paralysis.

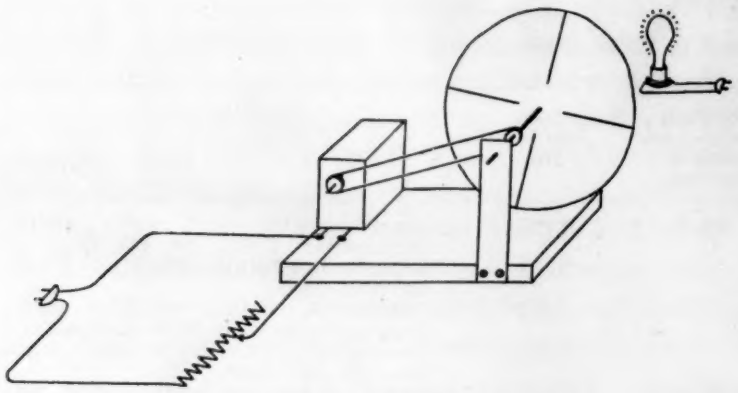

FIG. 1. A simple stroboscope.

number of rotations of the disk in a given period of time, which, when multiplied by the number of slits, will give the corresponding number of ciliary beats.

Organisms which will not move about much or side-view preparations of ciliated epithelium are best suited for demonstration purposes. Rotifers like Philodina and various attached Infusorians are excellent material, although with proper handling even an active form like Paramecium can be used.

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A NEW MATERIAL FOR MOUNTING NERVE TISSUE SECTIONS IN PARAFFIN FOR SILVER STAINING OR RESTAINING

EGG albumin solution used to affix nerve tissue sectioned in paraffin to slides has not proven completely satisfactory. Sections so mounted are easily lost when the slides are passed through the various solutions. The histological picture obtained in those sections successfully carried through is not absolutely clear. While attempting to remove the haziness from such material, it soon became evident that the proteins of the albumin are responsible for the gray background. Some other mounting media were therefore considered. One which would have no reducing properties and which would, at the same time, hold the sections in place was desired. Because of the inertness of starch, a paste of this substance was tried. The following form of paste gave the most satisfactory results: 1 gm starch thoroughly mixed with 10 cc of cold water was added to 20 cc of boiling distilled water and constantly stirred until the suspension, which is opalescent, is uniform and free from lumps. Two drops of hydrochloric acid were then added, and the solution was boiled for an additional three to five minutes. After cooling, a small crystal of thymol was added as a preservative. The result is a clear thin paste which is used very much the same as the albumin fixative. The paraffin sections which are placed on the slide covered with the hydrolyzed starch suspension are allowed to dry for two to three days in an oven at 45° C.

This fixing material was used on sections from various sized blocks of tissue which had been impregnated with silver according to Bielschowsky's or Cajal's method. These blocks were sectioned and mounted serially. Out of 500 sections of one series, only one section was lost in the solutions. In all cases, the resulting pictures were clear. No precipitate was evident.

In another series of tests, fresh formalin fixed tissue was sectioned in paraffin and impregnated after being fixed to the slide. In this way a quite even staining reaction was obtained. The inevitable gradations which occur in mass staining were avoided. In addition, the time necessary for impregnation was reduced to less than half. These sections were mounted and dried, passed through xylol into water, through the graded alcohols, and washed for about fifteen minutes and then allowed to remain in pyridine over night. Next, the tissues were washed in distilled water for about ten minutes and put into a solution of 5 per cent. silver nitrate for three hours in the dark. They were then transferred into a solution of ammoniacal silver nitrate, *i.e.*, 200 cc of 5 per cent. silver nitrate solution plus 5 cc of 10 per cent. sodium hydroxide. Add ammonia, drop by drop, until the precipitate dissolves. The sections are allowed to remain in this solution for half an hour, then rapidly washed in distilled water, placed in a 10 per cent. formalin solution for about 5 minutes. After this, they are washed again and may be toned in gold and left in hypo for two minutes, then dehydrated, cleared and covered in the usual way.

This method stains the cells as well as neurofibrillae. Further work is being done in applying this method to other routine neurological techniques, such as Bodian's, modified Bielschowsky's and Ranson-pyridine methods.

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